

PAEDIATRIC THORACIC DAMAGE CONTROL RESUSCITATION FOR BALLISTIC INJURY: A CASE REPORT

BR Cooper, A Mellor, A Bruce, A Hall, PF Mahoney

Royal Centre for Defence Medicine

Summary

This case is of an 8 year old child who had a cardiac arrest and an Emergency Department thoracotomy (EDT) following a penetrating fragmentation injury to the chest. The management included damage control resuscitation, recombinant Factor VIIa and a successful emergency department thoracotomy.

Case report

An 8 year old boy suffered penetrating fragmentation injury to his chest after a legacy munition he was playing with exploded. His sister suffered less severe injury but another child was killed. His father brought them to a U.K. Military Forward Operating base (FOB) in Helmand Province, Afghanistan about three and a half hours after the incident. Initial first aid was provided by UK ground troops and the pre-hospital evacuation care by a Consultant led Medical Emergency Response Team (MERT). During the pre-hospital phase the child's AVPU score fluctuated between V and P but improved with 100ml aliquots of crystalloid given via an intra-osseous device in his right tibia. In flight he required simple airway manoeuvres and occasional Bag-Valve-Mask assisted ventilation and his Glasgow Coma Score was 13/15 on arrival at the Emergency Department (ED) of the UK Joint Forces Field Hospital, four and a half hours after injury. He looked pale and unwell.

Primary survey examination revealed three small entry wounds on the anterior chest wall; one close to the left sternal edge, one on the right sternal edge and one close to the right sterno-clavicular junction. He had further penetrating fragmentation injuries to the right maxilla and the left thigh. AP and lateral chest films demonstrated a fragment close to the right hilum within the mediastinum but no obvious haemothorax, mediastinal widening or change in heart borders was evident (Figure 1). No obvious site of haemorrhage could be identified clinically or with ultrasound. Haemoglobin (Hb) on admission to hospital was 15.4 g/dl and prothrombin time (PT) was 10 seconds.

The decision was made to take the child to the operating theatre for further wound management and a rapid sequence induction (RSI) was performed. Fifteen minutes after RSI the patient became profoundly bradycardic and cyanotic (despite ventilation with 100% oxygen) and progressed to a pulseless VT arrest. Paediatric Advanced Life Support was commenced as per Resuscitation Council (UK) Guidelines [1] including 3 x 100J DC Shocks. Given a high index of suspicion for mediastinal injury, pericardiocentesis was performed. 50mls of blood was drained with a subsequent return of spontaneous



Fig 1. X-ray

circulation. One minute later he suffered a PEA arrest but drainage of a further 150ml of pericardial blood restored his circulation. The child was resuscitated with packed cells, fresh thawed plasma and 2.4mg of rFVIIa swiftly followed by a clam-shell thoracotomy performed by the Consultant General Surgeon and Consultant Orthopaedic Surgeon within the ED. There were no cardio-thoracic or paediatric surgeons available in Southern Afghanistan at that time. A large clot was evacuated from around the right side of the heart and a hole in the right ventricle repaired surgically. A further 2.4mg dose of rFVIIa was given twenty minutes after the initial dose. The patient remained stable post procedure and the chest closed with one mediastinal drain and one chest drain in situ.

The child was transferred to the Intensive Care Unit where arterial blood gases revealed a metabolic acidosis (pH 7.1). He was warmed to 36°C and commenced on high dose intravenous Meropenem. His acidosis corrected over the next six hours with maintenance fluid further warming and he was extubated 12 hours after his initial resuscitation. Total blood loss into the chest drains in the first 12 hours post procedure was minimal. His post operative Hb was 12.9 g/dL and PT was 21.2 seconds.

The other wounds were debrided the following morning under general anaesthesia and he was transferred to the ward. He was discharged home twelve days later.

Discussion

In penetrating thoracic trauma Emergency Department resuscitative thoracotomy (EDT) is a well documented procedure [2]. Most of the published data in paediatric thoracic

Corresponding Author: Captain B Cooper RAMC(V)
Specialist Registrar in Emergency Medicine, 212 Field
Hospital RAMC(V)
E: brcooper78@hotmail.com

trauma is taken from children who have suffered stab or gunshot wounds rather than penetrating fragmentation injury due to exploding munitions.

In a review of the published data from the past 25 years Rhee et al demonstrated that EDT has an overall survival rate of 8.8% in penetrating trauma [3]. The highest survival rate was 19.4% in patients with penetrating cardiac wounds, especially when associated with pericardial tamponade.

Similar outcomes for EDT in penetrating trauma in children have been demonstrated when compared to adults and that these outcomes are largely determined by injury mechanism and the patient's physiological status on arrival in the ED [4].

Early recognition of cardiac tamponade, prompt pericardial decompression, and control of cardiac haemorrhage are the key components to patient survival following penetrating wounds to the heart [5]. This patient had a number of elements in his favour when he presented: He was conscious on arrival in the ED, (albeit showing signs of shock), initially responded to fluid boluses and his cardiac arrest was witnessed.

The principles of damage control resuscitation practised within the UK Military are described elsewhere in this journal [6,7] as are UK Military Guidelines for use of rFVIIa [8].

The rFVIIa was given to this patient after 4 units of packed cells and two of fresh thawed plasma as the team were anticipating major blood loss and trauma induced coagulopathy. Significant post operative coagulopathy did not occur. Rizoli et al conducted a retrospective cohort study of 242 trauma patients, 38 of whom received rFVIIa [9]. They demonstrated that although primary surgical control is still the primary intervention in massive haemorrhage, rFVIIa was associated with improved 24 hour survival and a strong trend towards increased overall in-hospital survival.

Most of the published work about paediatric rFVIIa in non-haemophilia bleeding conditions in paediatrics is anecdotal, case report or small series [10]. Kulkarni et al reported successful use of multiple doses of rFVIIa in two patients with severe bleeding from blunt traumatic liver injuries [11] and Morenski et al used rFVIIa in three paediatric patients with severe coagulopathy following cerebral injury [12]. It has also been used with success in reducing post-operative bleeding and blood product requirements in paediatric open-heart surgery [13, 14].

Currently, no guidelines exist on early use of rFVIIa in paediatric trauma but two doses of $120\mu\text{gkg}^{-1}$ were used in this patient. Matthew and Young writing in 2006 noted that no adverse effects (myocardial infarction, ischaemic stroke, pulmonary embolus or vascular graft occlusion) had been reported in any paediatric patients within 1 week after rFVIIa dosing [10].

Conclusion

In relatively austere surroundings and without paediatric or cardiothoracic surgeons the authors believe that the principles of Damage Control resuscitation, a well trained trauma team and appropriately experienced clinicians led to a successful outcome in this case.

References

1. Paediatric Advanced Life Support Resuscitation Guidelines 2005. Resuscitation Council (UK).
2. Wise D, Davies G, Coats T, Lockey D, Hyde J, Good A. "Emergency Thoracotomy: How to do it." *Emerg Med J* 2005;22:22-24
3. Rhee PM, Acosta J, Bridgeman A, Wang D, Jordan M, Rich N. "Survival after emergency department thoracotomy: Review of published data from the past 25 years". *J Am Coll Surg*. 2000; 190(3):288-298.
4. Rothenberg SS, Moore EE, Moore FA, Baxter BT, Moore JB, Cleveland HC. "Emergency Department thoracotomy in children – a critical analysis". *J Trauma* 1989; 29(10):1322-5.
5. Breaux EP, Dupont JB, Albert HM et al. "Cardiac tamponade following penetrating mediastinal injuries; Improved survival with early pericardiocentesis". *J Trauma* 1979; 19:461.
6. Hodgetts T, Mahoney P, Kirkman E. Damage Control Resuscitation. *J R Army Med Corps* 2007; **153**: 299-300.
7. Kirkman E, Watts S, Hodgetts T, Mahoney P, Rawlinson S, Midwinter M. A proactive approach to the coagulopathy of trauma: the rationale and guidelines for treatment. *J R Army Med Corps* 2007; **153**(4): 302-306.
8. Hodgetts TJ, Kirkman E, Mahoney PF, Russell R, Thomas R, Midwinter M. "UK Defence Medical Services guidance for use of recombinant Factor VIIa (rFVIIa) in the deployed military setting". *J R Army Med Corps* 2007; **153**: 307-309.
9. Rizoli SB, Nascimento B Jr, Osman F, Netto FS, Kiss A, Callum J, Brennan FD, Tremblay L, Tien HC. "Recombinant activated coagulation factor VII and bleeding trauma patients". *J Trauma* 2006;61(6):1419-25
10. Mathew P, Young G. "Recombinant factor VIIa in paediatric bleeding disorders – a 2006 review". *Haemophilia* 2006; 12:457-452.
11. Kulkarni R, Daneshmand A, Guertin S et al. "Successful use of activated recombinant factor VII in traumatic liver injuries in children". *J Trauma* 2004; 56:1348-1352.
12. Morenski JD, Tobias JD, Jimenez DF. "Recombinant activated factor VII for cerebral injury-induced coagulopathy in paediatric patients: report of three cases and a review of the literature". *J Neurosurgery* 2003; 98:611-616.
13. Razon Y, Erez E, Vidne B, Birk E, Katz J, Tamari H, Dagan O. "Recombinant factor VIIa (Novoseven) as a haemostatic agent after surgery for congenital heart disease". *Paediatr Anaesth* 2005; 15(3):235-40.
14. Tobias JD, Simsic JM, Weinstein S, Schechter W, Kartha V, Michler R. "Recombinant factor VIIa to control excessive bleeding following surgery for congenital heart disease in pediatric patients". *J Intensive Care Med* 2004; 19(5):270-3.